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Impact of a mathematics early teaching experience for undergraduates: A teacher preparation recruitment strategy

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ABSTRACT

Declining enrollments in teacher preparation programs across the United States signal a critical need for institutions of higher education to consider innovative recruitment initiatives. This pilot study investigates a novel approach to recruiting undergraduates into a teacher preparation program. Nine participants, mostly first-year college students, engaged in a year-long experiential learning program. The program provided participants with an early teaching experience in a classroom-like setting by engaging them in the collaborative development, planning, and teaching of mathematics in a summer camp for high school students. Data were collected throughout the year on their: planned major, attitudes towards mathematics and mathematics education, mathematics teaching self-efficacy, and perceptions of the program. Results showed the program was successful at improving attitudes, increasing self-efficacy, and stimulating reflection on a potential career as a mathematics teacher. Participants also shared positive impressions of the experience. Implications for research and future practice are discussed.

Keywords: mathematics, teacher preparation, recruitment, attitudes, self-efficacy

INTRODUCTION

Critical teacher shortages have been a cause for concern in recent years (Yarrell, 2022). Those shortages are more pronounced in specific fields, such as mathematics, science, and special education (Feng & Sass, 2017). Despite increased demand for teachers due to increasing student enrollments, changing student-teacher ratios, and a high rate of attrition, the teaching workforce supply has declined (Sutcher et al., 2019). Podolsky et al. (2016) reported that enrollments in teacher preparation programs, the main pipeline for producing new teachers and a key attributing factor to the teacher shortage (Will, 2022), decreased by 35.0% from 2009 to 2014. As a result of the supply-demand inequities, many schools have resorted to hiring underqualified teachers (i.e., teachers teaching outside of their licensure area or lacking licensure credentials) (Dee & Goldhaber, 2017) and states have modified licensure requirements (e.g., creating emergency licenses or alternative licensure pathways) (Nguyen et al., 2022). Unfortunately, these short-term solutions may come with negative impacts for students, teachers, and schools. Underqualified teachers are more likely to end up serving disadvantaged students at a disproportionate rate further exacerbating existing disparities (Carothers et al., 2019; Castro et al., 2018). Moreover, teachers with minimal formal preparation for teaching are more frequently found in the difficult to staff subject areas, such as mathematics and science (Nguyen et al., 2022) and turn over at a higher rate than those who have formal teacher training in the area they are teaching (Ingersoll et al., 2014). This turnover in already difficult to staff subject areas then creates more teacher vacancies and perpetuates the teacher shortage problem.

Two approaches to alleviating the teacher shortages are clear: the teacher pipeline must be increased, and teacher attrition needs to be decreased. The project described herein is focused on the former and aims to increase enrollments in a mathematics education teacher preparation program at a small liberal arts university by recruiting incoming undergraduates to participate in an early teaching experience. The existing literature on recruitment and retention within both teacher preparation programs and the teaching career motivated the design of this early teaching intervention.

LITERATURE REVIEW

Several studies have explored the use of internships or early field experiences for recruitment into science and/or mathematics teacher preparation programs (e.g., Borgerding, 2015; Demir et al., 2019; Nguyen et al., 2022; Wong-Ratcliff & Mundy, 2019). The most effective recruitment programs incorporated:

(a) authentic teaching experiences and interactions with high school students (Artz & Curcio, 2008; Luft et al., 2005; Tomanek & Cummings, 2000; Watson et al., 2011),

(b) peer collaboration and support (Artz & Curcio, 2008; Colabianchi & Matney, 2020; Matney, 2018),

(c) reflection on teaching and learning (Luft et al., 2017; Worsham et al., 2014), and

(d) timely pedagogical support from experts (mentor teachers or education professors) (Matney, 2018; Worsham et al., 2014).

Luft et al. (2017) advocated for teaching experiences themselves to serve as recruitment experiences. When given an early teaching experience, whether for undeclared majors (Shulman & Armitage, 2005), science, technology, engineering, and mathematics (STEM) majors (Bush et al., 2022; Cook et al., 2022; Moin et al., 2005), or students interested in education (Romm et al., 2010; Watson et al., 2011), the individual can more aptly reflect on a career in teaching. Experiencing the rewards of teaching has been shown to be a strong factor informing the choice to pursue teaching credentials (Demir et al., 2019). Moreover, individuals who have had authentic teaching experiences are less likely to leave teaching within the first five years (AACTE, 2013; Huling, 1998), probably because their conceptions of the challenges and realities of the job are informed from their prior experiences.

Some successful recruiting initiatives point to teaching-like experiences or “third-spaces” (e.g., Bush et al., 2022; Cooper & Nesmith, 2013; Gutierrez, 2008; Hammond, 2002; Shulman & Armitage, 2005), where individuals can practice teaching without formal evaluation and pre-established classroom norms, allowing them autonomy to make decisions about best practices for teaching content, motivating learners, managing the classroom, and meeting students’ needs. Several studies found that first-hand experiences with teaching, no matter how informal, served as positive influences in the decision to become a teacher (Demir et al., 2019; Shulman & Armitage, 2005). For example, Watson et al. (2011) found that prospective teachers felt more confident after they designed and taught science lessons to children at the UTC Challenger Center, an example of a third-space. Alternatively, field experiences and internships that were mostly observational in nature showed minimal success with recruiting STEM majors into education (Borgerding, 2015; Tomanek, 1996; Tomanek & Cummings, 2000).

A few studies have described teacher education programs with non-traditional field experiences in one specific type of third-space, educational summer camps. For instance, Green and Piel (2012) tied a summer camp field experience to a graduate-level mathematics methods course. In this case, the graduate students led a summer camp for elementary age pupils utilizing the skills they learned in the methods course, which provided the graduate students with “guided constructivism” experience with teaching. Cooper and Nesmith (2013) compared a traditional field experience (in an elementary school classroom) with a summer mathematics camp field experience. Interestingly, they found that the summer camp provided more room for teacher candidate growth because they had the autonomy to focus solely on the students’ needs and alignment of their teaching methods with the best practices learned in their methods course, as opposed to the traditional setting, where student teachers tend to mimic their supervising practitioner’s routines and methods. Colabianchi and Matney (2020) engaged their education students in their first through fourth year in designing and running mathematics camps in a school-like setting. In teams, the undergraduates assumed responsibility for all aspects of the camp from organizing, selecting content, and teaching. Matney (2018) determined that “teaching efficacy and authenticity comes about for these prospective teachers as a result of having the responsibility to foster learning and engagement of a large group of students (p. 79).” Furthermore, the camp fostered a community of learners, where the prospective teachers supported one another in “professional families” who collaborated on all aspects of the camps. Although the aforementioned studies emphasized the benefits of field experiences in summer camps for prospective teachers, the studies did not utilize the field experiences to recruit undergraduates into their teacher education programs. The participants were those who were already pursuing teaching credentials.

An alternative use of summer camps to recruit future teachers has shown some promise. In these cases, the summer camps were used to expose high school students to the possibilities of teaching as a means to recruit into teacher education programs (e.g., Carothers et al. 2019; Castro et al., 2018; Irvine & Fenwick, 2011). These programs typically introduced teaching and teaching methods, as well as provided an overview of licensure pathways, but did not engage participants in authentic teaching activities (Carothers et al., 2019).

Utilizing the existing research on prospective teacher recruitment initiatives involving early teaching experiences, the researchers aimed to provide a teaching experience in an educational summer camp (i.e., a school-like setting) for first-year undergraduate students. To address teacher shortages in mathematics, the leadership in teaching program (LTP) was established. The program recruited incoming STEM, education, and undeclared undergraduates to participate in a year-long experiential learning program, including cohort-based course work, training, planning, and teaching practice. The program culminated with the participants, herein referred to as mathematics camp *facilitators*, leading mathematics educational activities for high school students during a summer camp, providing early exposure to a teaching experience for the undergraduates in their first year of college. This experience, at an early enough time point to influence academic and career choices, was aimed to increase interest, self-efficacy beliefs, and awareness of mathematics teaching. Research has shown that not only are academic and career choices typically aligned with one’s interest and self-efficacy beliefs (Lin et al., 2018), but self-efficacy beliefs are also most likely to be influenced early in the teacher’s development (Hoy, 2004). Further, Matney (2018) demonstrated that the combination of cohort-based coursework and from the ground-up, peer-collaborative, summer camp development to implementation can lead to the creation of a “professional family” and produce increased teaching self-efficacy.

The authors investigated changes in the undergraduates’ planned majors and changes in their attitudes towards mathematics and mathematics education after the year-long experiential learning teaching program. Changes in participants’ mathematics teaching self-efficacy were also examined, as well as the social validity/acceptability of the year-long experiential learning teaching program for participants.

METHODS

Participants

Participants were eligible to participate in this study if they:

(a) were an incoming first-year undergraduate student,

(b) had an average grade of A- or higher across high school math classes or a score of 600 or higher on SAT,

(c) indicated an interest in education or STEM-related content areas on their application to the university,

(d) committed to completing the full LTP, including the week of the summer camp, and

(e) consented to participate in the study.

Some chose to participate in the program, but did not consent to participate in the study, and therefore did not complete study measures and are not included here.

Participants included a total of nine undergraduate students. Most identified as female (n=7; 77.8%) and white, non-Hispanic (n=7, 77.8%). One was a first-generation college student. All were incoming first-year students when they began the experiential learning program, and 66.7% (n=6) indicated a prospective (undeclared) education major at this time.

Procedures

After receiving approval from the university Institutional Review Board, the first author identified eligible incoming first year students and invited them to participate in LTP by sharing an informational handout. If a student indicated interest, she reviewed the inclusion criteria with them to confirm eligibility and give them an opportunity to ask questions and provide informed consent. Students were allowed to participate in LTP even if they did not consent to participate in the research study. LTP first ran in 2019-2020 with 29 first-year undergraduate participants beginning the program in fall 2019. When the summer 2020 mathematics camp experience was cancelled due to the pandemic, a new cohort of undergraduate participants was recruited for participation during the 2021-2022 academic year. Using the same recruitment procedures, 19 incoming undergraduate participants were recruited to begin the program in fall 2021 and participate in the study.

Leadership in Teaching Program

LTP was created to provide an early teaching experience to undergraduates in their first year of studies in an effort to recruit more students into mathematics teacher education by exposing them to the rewards and realities of teaching mathematics. The program design, informed by Artz and Curcio (2008) and Colabianchi and Matney (2020), entailed a sequence of three one-credit courses: leading a math academy I, II, and III, which ran in fall, spring, and summer semesters, respectively. The courses met for one-hour per week during the fall and spring and eight-hours per day for one week in the summer. All three courses were co-taught by a mathematics professor and a mathematics education professor (the first author). A third-year undergraduate enrolled in mathematics education coursework, who demonstrated strong potential and enthusiasm as a teacher and leader, was invited to participate in the program as near-peer mentor/role-model to the first-year students. When mentors are close in age to mentees (such as junior and senior undergraduates mentoring first and second-year undergraduates, or undergraduates mentoring high school students), mentoring has been shown to contribute to personal, educational, and professional growth, and to increase interest and engagement for STEM students (Tenenbaum et al., 2014).

The purpose of the program was for the undergraduates to explore teaching mathematics through authentic experience in a classroom-like setting with real high school students. Its design incorporated the key aspects of effective programs for generating interest in teaching discovered in the literature:

(a) authentic experience with students (e.g., Artz & Curcio, 2008),

(b) peer collaboration and support (e.g., Matney, 2018),

(c) reflection on teaching (e.g., Luft et al., 2017), and

(d) experts providing timely support to participants (e.g., Matney, 2018).

Through peer collaboration, the undergraduates would engage in all aspects of teaching: planning, implementing, and reflecting. The program emphasized active, inquiry-based learning that aimed to utilize the common core standards for mathematical practice: persevering in problem solving, reasoning abstractly and quantitatively, constructing viable arguments, modeling, using tools, attending to precision, and looking for structure and repeated reasoning (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Student-centered approaches to teaching, such as these, have been correlated with teachers' enjoyment associated with teaching (Trigwell, 2012).

Fall: Course I

In the first course, participants were organized into teams that participated in a menu of potential mathematics tasks for the summer camp. For example, some of these included 'the birthday problem' and 'the 4 fours puzzle.' The professors led the tasks, exposing the undergraduates to the content and possible methods for presenting the tasks, while solidifying their content knowledge. The mathematics education professor highlighted the teaching practices that were employed in the initial task presentations as a launching point to discuss teaching best practices. By the end of the first course, two mathematical tasks were eliminated from the summer camp program based on feedback from the students and each team of undergraduate students had developed their own teaching plan for one of the previously explored tasks. At that time, participants were also reminded of

Table 1. Schedule & facilitator team responsibilities: Mathematical tasks

	Monday	Tuesday	Wednesday	Thursday	Friday
Arrival & ice breakers (9:00-9:30)					
Morning task (9:30-11:00)	Yellow	Blue	Green	Yellow	Red
Break & snack (11:00-11:15)					
Mini game (11:15-12:00)	Red	Yellow	Blue	Green	Blue
Lunch/get-to-know-you activities (12:00-12:45)					
Break & transition (12:45-1:00)					
Afternoon task (1:00-2:30)	Green	Red	Yellow	Blue	Green

Note. Colors represent teams

expectations for continuing in TLP, including the requirement to be available in the summer. Eight students exited the program after course I because of personal issues (e.g., mental health and parent illness) or because they could not commit to being available the week of the summer camp (course III).

Spring: Course II

Expanding on the first course, in the next semester the students and professors collaboratively designed Camp AIM, a name that originated from a student during a collective brainstorming session in class. The camp tasks and activities were selected based on feedback from the undergraduates from course I. Also in course II, the instructor teams of undergraduates were solidified, and a schedule of camp tasks and team responsibilities was established. Teams then developed their own facilitation plans, which included decisions about the distribution of responsibilities, creation of handouts/visuals, methods for motivating the campers, and more. Teams had opportunities to practice facilitating their tasks with their peers to rehearse and receive feedback from the collective group. By the conclusion of the second course, the plans for the camp activities were finalized and stored in a collaborative digital folder. After completion of course II, participants were asked to recommit to their plans to serve as facilitators during Camp AIM in summer 2022. Two additional students left the program after course II because of outside obligations that conflicted with participation during the week of Camp AIM.

Summer: Course III & Camp AIM

In the culminating course, using the experiences and preparations from the first two courses, the nine participants from the 2021-2022 cohort facilitated the mathematics activities in instructor teams. This included eight undergraduates who had just completed their first-year of college and one mathematics and secondary education major peer mentor who had just completed their junior year and who completed course I and course II in 2019-2020.

Camp AIM was conducted over the course of five, 6-hour days. The schedule followed the structure shown in **Table 1**. The participants, undergraduate facilitators, ran every aspect of the camp and its daily schedule in pre-determined teams. They were responsible for preparing, leading, and reflecting on the daily activities of the camp with help from the third-year mentor. With fidelity, each day the facilitators:

(a) gathered at 8:30 am to begin preparing for the day,

(b) ran all daily activities according to the pre-defined structure and plan, and

(c) regrouped at 3:00 pm after the camp day to reflect, discuss successes and areas for improvement, and develop an informed plan for the subsequent day.

Some teams self-initiated meetings in the evening to practice their lessons. The program directors, the two professors who taught course I and course II, were present to supervise and provided support and advice as needed but did not participate directly in presenting camp activities.

The yellow, green, and blue teams consisted of two, three, and four undergraduates, respectively, groupings that originated naturally from collaborations in the preparatory classes. One undergraduate facilitator chose not the participate in the research study. Each color team was assigned responsibility for a mathematical task on four of the five days, as shown in **Table 1**. The undergraduate mentor was charged with leading three mathematical tasks, indicated with 'red' in **Table 1**.

The mathematical tasks and games utilized during the camp were some classics involving mathematical paradoxes, probability theory, calculus, compound interest, and more. The tasks were chosen with the purpose of exposing the campers to college-level mathematics concepts and to motivate students' interest in mathematics. Strategies for engaging and motivating students to learn mathematics include the discovery of patterns, use of games, incorporation of "gee-whiz" results like those from mathematical paradoxes, and challenging students to explain surprising mathematical results (Posamentier & Krulik, 2012). For instance, one morning task was the classic 4-fours problem, which involves writing an expression for the numbers 1 though 50 using exactly 4-fours (e.g., 2=4/4+4/4). One mini game was a variation on the card game Krypto. Pascals triangle and the Monty hall problem served as the bases for two of the afternoon tasks.

Besides a preparatory period immediately preceding an assigned task, teams assisted their peers with facilitating the other tasks. Typically, unassigned team members sat with the camper groups to provide one-on-one attention while the assigned facilitating team members were guiding the holistic aspects of the lesson. During preparatory periods, undergraduate teams reviewed and rehearsed their teaching plans. The mathematics education professor checked in with the teams during this time to answer questions, lend advice, and review the mathematics content if necessary.

In addition to the mathematics tasks, the undergraduates were assigned other duties such as greeting the campers at their cars, escorting campers across campus to the classroom, welcoming and entertaining the campers in the classroom as they arrived, escorting to/from and supervising lunch, and guiding campers to the departure location. These roles were distributed evenly by the mathematics education professor and rotated. A potential benefit of these informal interactions was to build relationships between the campers and the undergraduate facilitators, as well as to expose the campers to the university. The undergraduate facilitators completed their duties, with respect to both teaching and other aspects of the running and planning the camp, with fidelity. Readers interested in replicating this study can contact the authors for additional information on program implementation.

Data Collection

Electronic surveys were administered at five time points over the course of the year of participation in LTP. These time-points included:

(1) beginning of course I (fall pre-survey),

(2) end of course I (fall post-survey),

(3) end of course II (spring post-survey),

(4) start of course III/Camp AIM (summer pre-survey), and

(5) conclusion of course III/Camp AIM (summer post-survey).

At each time point, undergraduate participants consented to continuing their participation in the study.

Measures

Prospective major: At each of the first four time points, participants were asked to write in their planned academic major.

Mathematics attitudes: At each of the five time points, participants rated five items related to their attitudes about mathematics on a scale from one, *strongly disagree*, to five, *strongly agree*. These items were developed by the author based on the three components of attitudes: affect, behavior, and cognition (ABC model of attitude; Ajzen, 1993). Questions were generated to include all three attitude components (e.g., I find mathematics to be interesting; I plan to pursue a career in which I will use my math skills regularly; I do well when solving math problems, respectively). A Cronbach's alpha, calculated using a separate sample of undergraduate students who completed course I in 2019, indicated high internal consistency (alpha=0.79).

Mathematics education attitudes: At each of the five time points, participants rated four items related to their attitudes about mathematics education on a scale from one, *strongly disagree*, to five, *strongly agree.* These items were developed to include statements related to affective, behavioral, and cognitive aspects of attitudes (ABC model of attitude; Ajzen, 1993) towards mathematics teaching (e.g., "Teaching math is appealing to me"). A Cronbach's alpha, calculated using a separate sample of undergraduate students who completed course I in 2019, indicated high internal consistency (alpha=0.85).

Mathematics teaching self-efficacy: At time points four and five, participants completed *mathematics teaching efficacy beliefs instrument* (Enochs et al., 2000). This measure was developed to measure mathematics teaching efficacy beliefs in pre-service teachers and consists of 21 items that form two independent scales: *personal mathematics teaching efficacy* (PMTE) (alpha=0.88) and *mathematics teaching outcome efficacy* (MTOE) (alpha=0.75). Each item is rated from one, *strongly disagree*, to five, *strongly agree.*

Course perceptions: At the end of Camp AIM, participants rated their agreement with eight items focused on their perceptions of LTP courses and outcomes on a scale from one-five. The post camp survey also included four open ended questions about participants' perceptions of Camp AIM (e.g., "In your opinion, what was the best thing about being a facilitator for Camp AIM," and "How have your views of yourself as a mathematics doer and teacher been impacted by this experience, if at all?").

Data Analyses

Because we considered this a pilot study, to avoid type II error, students who dropped the course were not included in the final sample. Data were reverse coded as needed before calculating descriptive statistics for sub-scale scores. Due to the small sample size, non-parametric Wilcoxon matched-pairs tests were used to statistically compare changes in participants' scores over time. Responses to open-ended questions were reviewed independently by both authors to generate and come to consensus on themes that answered our research questions. Based on preliminary qualitative findings showing potential differences between prospective major groups (e.g., elementary education, secondary education, math-related), we then calculated individual change scores from the beginning to end of Camp AIM to explore individual differences and patterns based on prospective major.

RESULTS

Results presented below are parsed into three subsections related to changes in:

(a) prospective major and career plans,

(b) attitudes,

(c) self-efficacy, and

(d) perceptions of the of LTP.

Table 2. Changes in prospective majors

Participant	Fall pre-survey	Fall post-survey	Spring post-survey	Summer pre-survey
1	Elementary education & undecided content area	Elementary education & English		
2	Elementary education & history	Elementary education/undecided content area	Business	
3	Early childhood education & environmental science	Elementary education & environmental science		
4	Undecided/no response	Human services		
5	Actuarial science & data analytics			
6	Undecided, leaning towards mathematics, or education		Actuarial science	
7	Education & English	Undecided/no response	Secondary education/English	
8	Elementary education & history			
9*	Secondary education & mathematics			

Note. *Peer mentor who completed course I & course II (& surveys) during first-year & course III in summer between junior & senior year & Red: Education major; Green: Mathematics-related major; & Blue: Mathematics and education major.

Table 3. Camp AIM experience impact on career plans

Theme	Quote
Solidified existing teaching career plans	"Before joining this camp, I knew I wanted to be an elementary education teacher. After this camp, my feelings of becoming a teacher are so much stronger" (participant 1).
	"This has just further proved that I cannot wait to be a teacher!" (participant 3).
	"I definitely want to pursue teaching after this camp" (participant 7).
	"I think it has confirmed my love for teaching more, but I think it posed a question, elementary, or secondary" (participant 8).
	"This experience has just set more in stone my choice to become a high school mathematics teacher" (participant 9)
Caused them to reconsider teaching	"It made me reconsider teaching, I have been debating if I want to, but doing camp made me want to look into teaching again" (participant 2).
	"I never thought about becoming a teacher … but after teaching this camp I've realized that … I could potentially fall back on teaching" (participant 5).
	"This experience has caused me to want to be a mathematics teacher more. I was always on fence" (participant 6).
Connection to existing career plans	"I want to be a speech pathologist, but I think there is a teaching aspect in that, so this experience has made me more excited" (participant 4).

Prospective Major & Career Plans

As shown in **Table 2**, of n=9 participants, six began the program with planned education majors; however, only one planned to be a mathematics and education major. At the end of course II (spring), five planned to be education majors. Three additional participants planned to major in math-related fields (actuarial science, data analytics, and business). Two of these participants had been considering an education or mathematics major at the beginning and end of course I but switched their prospective major after course II. None changed their planned major from the end of course II to the beginning of Camp AIM.

Three themes emerged from open-ended responses related to the impact of Camp AIM on future career plans. These included

(1) solidifying existing teaching career plans,

(2) causing them to reconsider teaching as a career, and

(3) connecting the experience to existing career plans (**Table 3**).

Participants perceived a positive impact of Camp AIM on their future careers, even if it did not cause them to become mathematics education majors. For participants who were planning mathematics related–but not education–majors when Camp AIM began, LTP prompted them to (re)consider becoming a mathematics teacher. For those already planning to be teachers, Camp AIM experience further solidified these plans.

Attitudes

Overall, survey measures and open-ended responses showed that participants improved in their attitudes toward mathematics and mathematics education during LTP. However, limited growth occurred during course I and course II. For both attitudes towards mathematics and attitudes towards mathematics education, gains were primarily observed over the course of the week of Camp AIM (course III).

As shown in **Figure 1**, participants' attitudes towards mathematics were somewhat variable after completion of course I (mean [M]=3.65, standard deviation [SD]=0.86) and course II (M=3.56, SD=0.73) but did not show much change from a pre-course I mean of 3.60 (SD=0.65). However, by the beginning of Camp AIM, participants' attitudes towards mathematics improved slightly (M=3.71, SD=0.66), and showed even greater growth to a mean of 3.90 (SD=0.72) by the end of the week. The change in attitudes towards mathematics from the beginning of course I to the end of Camp AIM was statistically significant, Z=2.21, p=.027.

Participants improved in their attitudes towards mathematics education only after completing the week of Camp AIM (see **Figure 1**). From the beginning of course I to the beginning of Camp AIM (course III), mean scores on attitudes towards mathematics education were relatively stable (M=3.47, SD=1.01; M=3.50, SD=1.05; M=3.47, SD=0.85, M=3.50, SD=0.82, respectively). From the beginning of the week to the end of the week of Camp AIM, participants' mean mathematics education attitude score increased from 3.50 (SD=0.82) to 3.83 (SD=0.94). The change from before course I to after course III was statistically significant, Z=2.06, p=.04.

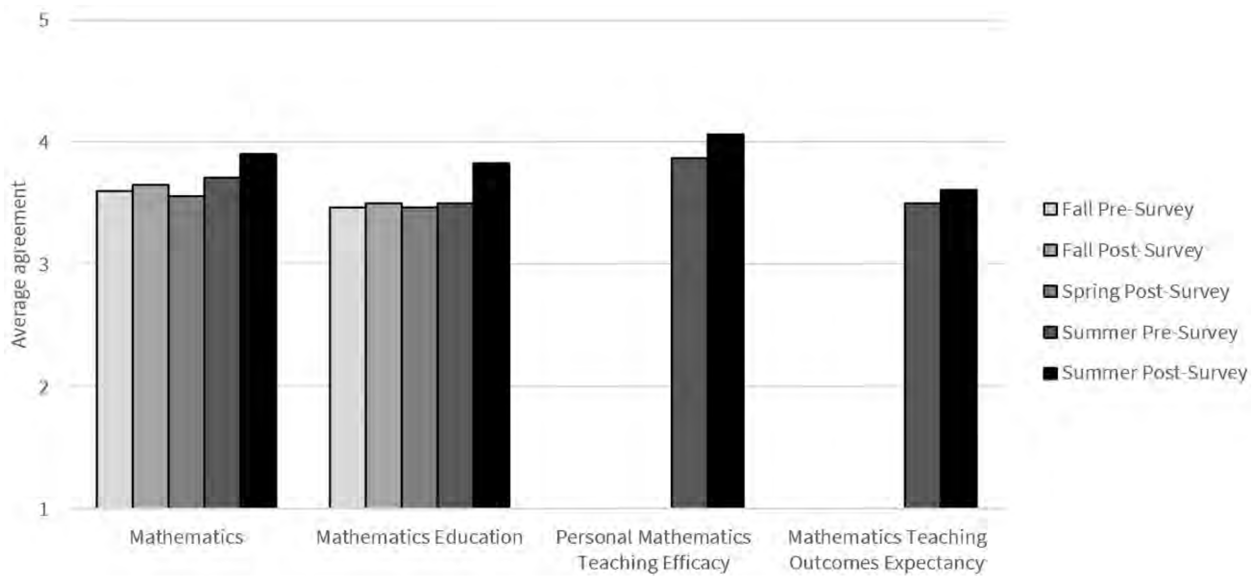

Figure 1. Change in attitudes & beliefs over time (n=9) (Source: Authors' own elaboration)

Table 4. Change in individual attitudes from pre- to post-Camp AIM

Participant	Math attitudes	Math education attitudes	Personal math teaching efficacy	Math teaching outcomes expectancy
Elementary education prospective majors				
1	+0.50	+0.50	+0.31	+0.13
3	+1.00	+1.00	+0.15	+0.63
8	+1.25	+1.25	+0.31	+0.00
Secondary education prospective majors				
7	+0.25	+0.25	+0.03	+0.13
9	-0.25	-0.25	+0.69	+0.38
Mathematics-related prospective majors				
2	+0.25	+0.25	-0.23	+0.50
5	+0.25	+0.25	+0.23	**-0.63**
6	+0.50	+0.50	+0.46	+0.13
Other prospective majors				
4	**-0.75**	**-0.75**	-0.23	-0.25

Note. **Black**: Decrease 0.50-0.99; Blue: Decrease 0.05-0.50; Red: ~No change (±0.05); Yellow: Increase 0.05-0.49; Brown: Increase 0.50-0.99; & Green: Increase of 1 or greater

Self-Efficacy

Participants' mathematics teaching self-efficacy also increased on average from the beginning to the end of camp. Participants began the week with a mean PMTE score of 3.87 (SD=0.43), which increased by 0.19 to a mean of 4.06 (SD=0.57) by the end of the week. Participants began the week with a lower mean mathematics teaching outcomes expectancy of 3.50 (SD=0.25), which increased by 0.11 to a mean of 3.61 (SD=0.51) after completion of Camp AIM. While there was a larger increase in PMTE, neither change was statistically significant (Z=1.73, p=0.84 and Z=0.92, p=0.36, respectively).

Similar to the quantitative results, open-ended responses consistently showed participants' increased confidence in both their mathematics abilities and their mathematics teaching skills after completing the week of Camp AIM. This was especially true for participants who began the program with lower confidence in their mathematics abilities, who happened to primarily be prospective elementary education majors. For example, participant 8 shared, "I love teaching math now and I like math more and I have kinda faced the subject that I have always struggled with. I am so grateful." Similarly, participant 1 shared, "This camp has made me so much more confident in both my ability to do math, and my ability to teach. I feel more comfortable teaching and instructing students." Participant 9, the peer mentor who planned to be a mathematics teacher before starting the program and was confident in his mathematics abilities, shared how the experience even further reinforced his confidence as a mathematician and mathematics educator:

> If anything, my views as I see myself as a mathematics doer and teacher have been reinforced and cemented by this experience. I feel more confident in my abilities to not only teach math but to make it interesting to everyone.

Exploratory Analyses by Prospective Major

As shown in **Table 4**, prospective elementary education majors showed the most consistent, positive growth in attitudes towards mathematics and mathematics education over the course of the week of Camp AIM as individuals and a group. All prospective mathematics-related majors also showed consistent positive change in attitudes, but the increase was not as large. Participant 8, who identified a prospective education major at the beginning course I, showed the greatest individual improvement

Table 5. Participants' perceptions of acceptability of leadership in teaching program (n=9)

Item	Mean (SD)	Range
Course I & course II		
I was able to use methods I learned about in course I & course II to motivate high school students attending Camp AIM.	4.89 (0.33)	4-5
Content from course I & course II prepared me to engage high school students at Camp AIM.	4.78 (0.44)	4-5
I was able to use best teaching practices I learned about in course I & II with high school students attending Camp AIM.	4.67 (0.50)	4-5
Course III (Camp AIM)		
I am glad I served as facilitator for Camp AIM	5.00 (0.00)	5
I will encourage others to consider serving as facilitators for Camp AIM.	4.78 (0.44)	4-5
I will consider serving as a facilitator for Camp AIM again next year.	4.56 (1.01)	2-5
Course III outcomes		
Through my Camp AIM experience as a facilitator, I learned even more about teaching & motivating high school students.	5.00 (0.00)	5
Through my Camp AIM experience as a facilitator, I learned even more about best practices for teaching mathematics.	4.78 (0.44)	4-5

in attitudes towards mathematics and mathematics education. Participant 4, who planned a human services major, showed the greatest decrease in attitudes, as well as consistent decreases in self-efficacy. In terms of growth in mathematics teaching self-efficacy, participant 9 showed the greatest increase in personal math teaching efficacy, despite decreased attitudes, followed by participant 2, who had switched to a prospective Business major after completion of course II. Participant 3, a prospective elementary education major, showed the greatest increase in mathematics teaching outcomes expectancy. Participant 5, who planned a math-related major from the beginning of the program, showed the greatest decrease in mathematics teaching outcomes expectancy but an increase in all other areas.

Acceptability of Leadership in Teaching Program

After completing courses I-III, participants reported highly positive perceptions of the course experience and outcomes, with all averaging *agree-to-strongly-agree* or greater (**Table 5**). All (100%) of participants provided the highest possible rating (5/5; *strongly agree*) indicating they were glad they served as facilitators for Camp AIM. All participants also *strongly agree*d they learned even more from Camp AIM experience beyond what they learned in course I and course II. Only one participant (participant 4) indicated they would not serve as facilitator at Camp AIM again.

Open ended responses were consistent with these positive quantitative perceptions of Camp AIM, with participants identifying the best part of Camp AIM as seeing the positive impact they had on the campers. Participant 6 shared, "It was so rewarding to see them get excited and learn new things based upon what we were teaching." Participants' recommendations for improving Camp AIM included: making camp longer, having more campers, knowing campers' mathematics abilities to have leveled tasks, and having more opportunities to practice before camp.

DISCUSSION & CONCLUSIONS

The purpose of this study was to promote positive attitudes towards mathematics and mathematics teaching, as well as improve self-efficacy related to mathematics teaching in students' first-year of college by completion of an early teaching experience. Improving beliefs about mathematics and mathematics teaching was a hypothesized pathway to recruit undergraduate students into mathematics teaching before decisions about majors and careers are solidified. There is evidence that such choices are typically aligned with the student's self-efficacy and interests (Lin et al., 2018). Furthermore, efforts to improve self-efficacy beliefs are most fruitful early in teacher preparation (Hoy 2004). Results from this pilot study provide preliminary support for this program.

Although summer camps have been previously used as field experiences (Colabianchi & Matney, 2020; Cooper & Nesmith, 2013; Matney, 2018), this study is the first to use teaching experiences in a summer camp to evaluate the recruitment of future mathematics teachers by raising interest and helping undergraduates make informed decisions when considering education or mathematics-education majors or careers. The camp provided a classroom-like setting, where the undergraduates could experiment with teaching methods and interact authentically with high school students. Findings of this study provide preliminary support that combining the authentic teaching experience with ground-up collaborative planning leads to undergraduate participants' significant positive changes in attitudes, improved self-efficacy beliefs about mathematics teaching, and reflection on a career in teaching.

Participants' attitudes towards mathematics and mathematics teaching were relatively stable during the preparatory coursework (course I and course II) and saw large improvements after their experiences facilitating Camp AIM (course III). This is consistent with the literature (e.g., Artz & Curcio, 2008; Borgerding, 2015), pointing to the authentic teaching in a school-like setting, where participants could experience the rewards of teaching, as the key component of the program.

Participants' perceptions of mathematics teaching self-efficacy increased on average from the start of Camp AIM to its conclusion. Gains in PMTE were greater than those for MTOE, though both saw improvements on average. Existing literature has similarly found that prospective teachers' PMTE tends to increase through practical experience, while MTOE increases less dramatically or even decreases with the same field experiences due to prospective teachers' "unrealistic optimism" (Hoy & Woolfolk, 1990; Swars et al., 2007).

Although participation in LTP did not yield more mathematics education majors, three participants with mathematics-related prospective majors specifically noted that the program caused them to reconsider a teaching career they had previously discounted. A longitudinal study will determine if the program leads to gains in recruitment to the teacher preparation program or teaching career at a later point (e.g., master's degree). However, LTP successfully (re)opened participants' eyes to the possibilities and rewards of the teaching profession. Several students wrote of the direct impact of Camp AIM on making them more certain of or excited about their career path and helping them decide they want to be a mathematics teacher.

Open-ended responses and exploratory analysis revealed an unanticipated benefit of this mathematics teaching experience for prospective elementary teachers. Looking at change across the four sub-scales, the prospective elementary school teachers most consistently showed positive change in attitudes and efficacy towards mathematics and mathematics teaching. Elementary teacher candidates have been identified as commonly fearful of mathematics content and teaching, with generally low self-efficacy beliefs and attitudes towards mathematics (Bursal, 2010; Segarra & Julia, 2022). Although, these individuals may not switch to become secondary mathematics teachers, this experience seemed worthwhile in shifting their attitudes towards mathematics and their beliefs about their abilities to teach mathematics - both shown to be essential because they impact learning and achievement of their future students (e.g., Charalambous et al., 2009; Leavy et al., 2017; Ma & Kishor, 1997).

Furthermore, this experience proved valuable and impactful for individuals with plans to pursue secondary mathematics teaching or who have considered or are wavering on mathematics teaching. Our participant majoring in secondary mathematics had the greatest overall gain in teaching efficacy perceptions. This experience enabled them to see themself as a capable mathematics teacher. The second highest increase in personal teaching efficacy was the undergraduate who was "always on the fence" about becoming a mathematics teacher. Participating in this early teaching experience enabled them to reflect on a career more aptly in teaching (Bush et al., 2022; Cook et al., 2022; Moin et al., 2005); thus, allowing them to make an informed decision about major and career plans before it is too late to do so–exactly the intention of the program. For future iterations of LTP or a similar program, it may be most effective to focus recruitment on those populations, where we saw the greatest gains and highest likelihood of yielding mathematics teachers: individuals interested in elementary teaching or secondary mathematics teaching, as well as those who are considering a teaching career as one of many options like our participant who was "on the fence."

Limitations & Future Research

Further investigation is necessary to determine if the program leads to more individuals choosing teaching careers or more specifically mathematics teaching jobs. The researchers will follow the participants throughout their college career to examine whether the benefits of the program (i.e., positive beliefs about mathematics and about one's mathematics teaching capabilities) maintain through the duration of the teacher preparation program. One could investigate whether the early teaching experience or the cohort relationships with likeminded peers and faculty impacts programmatic or institutional retention of the participants. Further studies, of longitudinal nature and with a larger sample size, are necessary to make generalizable claims about the program's long-term effects on undergraduates' decisions to pursue a mathematics teaching career or a teaching career in general. A larger, more diverse sample will also allow for moderator analyses to determine "for whom" the program has the biggest impact, examining, for instance, gender differences in experiences and outcomes. Additionally, this study should be replicated in other regions and countries to determine if contextual factors that vary by region (e.g., economics, perspectives toward a teaching career) impact program effectiveness. We did not consider these factors in this study. Future iterations of this program should measure such factors and incorporate strategies for promoting interest in teaching in advance of the early teaching summer experience, such as confronting misconceptions about teachers' job satisfaction and pay scales through informational activities earlier in the program (Adams et al., 2021). Further, once a larger scale study is conducted to determine the efficacy of this program, component analyses should be completed to consider which elements of the program are particularly effective. Such analyses were beyond the purpose and scope of this study but are important for implementation.

Nonetheless, this study provides preliminary support indicating the program was successful at boosting participants' interest in mathematics teaching and allowing the undergraduates to genuinely experience teaching in a positive manner that encouraged them to see themselves as future mathematics teachers. Allowing the students the autonomy in a third-space, such as a summer camp, to make instructional decisions as they see fit, may be a large contributing factor to the success of this program at changing attitudes towards teaching mathematics, as consistent with previous studies. The findings support the literature that shows early teaching experiences enable individuals to better reflect on a career in teaching. Although this program may not solve problems with teacher recruitment and retention in the short-term, improving attitudes towards mathematics and beliefs about one's mathematics teaching abilities, together with authentic teaching experience, is a positive step in solving a problem that requires a long-term investment.

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